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Ambient Intelligence in Healtcare Environments for Active Monitoring

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ABSTRACT

The introduction of monitoring systems may have a great potential to introduce Ambient Intelligence based monitoring techniques in healthcare environments. On the other hand, current research being sponsored by the European Union presents interoperability issues as a considerable obstacle to implement and fully explore the capabilities of such a technology. Therefore, and in order to contribute to overcome this drawback, we address the different methodologies put into operation in the healthcare sector, supported by a putative architecture which has been used in different healthcare institutions to suport RFID monitoring systems.

INTRODUCTION

In large-scale healthcare environments, control and spatial monitoring of patients, visits, staff, service providers, medication and equipments are extremely complex and generally do not respond to the needs, nor offer information on time for decision support. These barriers create a demand for new methodologies and technologies for problem solving that have to be studied, analyzed and implemented, in order to improve Quality-of-Service (QoS) and facilitate clinician and other staff work. The unequivocal positioning and identification of an entity (person or object) in a given moment and over time can provide a base for the development of several solutions for critical problems within the healthcare system. Recent academic research and publications are concerned with Radio Frequency IDentification (RFID) in the healthcare industry, however much study must still be performed in terms of the integration of such system with existing informations systems. Recent studies directed by the European Union, defining some of the possible and undergoing applications of position identification and monitoring using RFID, state to be possible to orientate this technology towards the needs of control and optimization of medication, lab tests, equipment, patients and staff (Ngai et al. 2009) (Chen et al. 2010) The different projects mentioned in these studies demonstrate the utility of this technology, unleashing some of its potential but also its limitations. From advantages and niches of opportunities of these projects, key limitation elements such as interoperation, integration, security, ubiquity, data quality, price and overload of existing infrastructure (e.g. networks) emerge. On the other hand, the degrees of confidence and excellence are mandatory to healthcare activity, and these environments of lesser forbearance can not flaw, equipments with slower time of response and greater reliability are needed, and intelligent data processing expertise may bring decision support.

In this work we describe and support a putative architecture which has been used in different healthcare institutions to support RFID based monitoring systems. The architecture core is based on a Multi-Agent System (MAS) and on WebServices approach that uses HL7 and other proprietary syntaxes to enable interoperation among the applications in the Healthcare Information System (HIS). Indeed, in healthcare, several standards have been defined for interoperability, being Health Level Seven (HL7) the most uniformly used by healthcare information system providers (HISP).

WORK AND DEVELOPMENTS

The AIDA platform is an example of an application based on Artificial Intelligence (AI) techniques, namely MAS, to overcome key limitations in the healthcare environment (Machado et al. 2008) (Machado et al. 2007).

In this work, we present an architecture and methodologies for implementing interoperation between ambient monitoring systems and the HIS in a scalable, manageable and productive manner in healthcare. The implementation of Service Oriented Architectures using MAS enables HL7 communication using modules and ensuring compliance to the defined specification, even when the monitoring service provider fails due to

technological limitations. Furthermore, the scalability of the system enables rearrangements within the MAS parallelization tasks. The introduction of intelligent behaviours in data processing through the modeling of inconsistencies and incompleteness in the existing information available within all solutions that are part of the HIS, has the potential to improve the results of the RFID system itself. Moreover, it can improve the overall quality of information within the HIS, using the information exchange between systems to validate theirs completeness and detect flaws in workflows and exceptional cases. The development of an RFID monitoring systems has been performed by different other systems such as those developed by (Chen et al. 2010), (Kim et al. 2008) or (Ngai et al. 2009), however the insights in the devised interoperability architecture presents another perspective to improve the behaviour and effectiveness of this genre of tool. Furthermore it strengthens the usefulness of RFID systems by increasing the amount of information that can be extracted from the data events they generate.

As future work, while the system is in a production phase, AI techniques, such as evolutionary algorithms, artificial neural networks or decision-trees, could be further studied to improve the behaviour of data validation, information consistency and knowledge extraction within the system. The use of interoperation platforms, such as the AIDA platform, addresses and resolves many of the concerns on existing studies required by the European Union. However future research must be held regarding the improvement of existing mis-detections and false alarms developed by these monitoring systems, which increase the entropy and error within the HIS.

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